Index

Numerals before and after colons designate chapters and pages respectively (e.g., 3:5 designates page 3-5).

Italicized numerals refer to figures illustrating the subject mentioned.

Above-ground soil piles:
description, 3:11-13, *12*
design, 5:76-78
operation, 8:1, 15

Adsorption, 2:*5*, 6; 3:32; 5:4-6; 9:5; C:4
activated carbon/zeolite 5:48, 67-68, 72

Advection, 2:1, 3, *4*, 11; 5:4; 8:15

Air:
emission calculation, 7:23
entry suction, 2:9-10; 3:36, 36
filled porosity (see Porosity, air-filled)
filter (*see Filter*)
injection, 3:9, 14; 5:6, 10, *11-12*,16-17
permeability:
definition, 2:10,13
estimation, 4:21, 27; D:1-12
measurement, 3:19, 31-32; 4:2-6, *4*, *5*, 21, 41-42; 5:*5*, 13, *14*; D:1-12
relationship to hydraulic conductivity, 2:10; 3:33; D:1
testing:
column, 4:2-4, 39; D:3-4
example, 4:41-42
field, 4:4-6; D:4-12
use in technology screening, 3:*17*, 31-32
saturation (see Saturation, air)
sparging, 3:13-14, *9*
water separator, 5:48-50; 7:19; 8:12

Airflow:
conversion, 8:9-11
measurement, 4:42; 5:58; 7:17; 8:9-11
modeling (*see Modeling*)
rates, 3:31-32; 4:34

Anemometer, 7:17; 8:6, 11

Anisotropy:
of the vadose zone, 2:15; 4:4, 47; 5:13, 23; D:9-10

Applicability
strategy, 2:1,*2*
SVE, 3:1-2
Bioventing, 3:2-3

Bacteria (*see Microorganisms*)

Barometric pressure, 4:27

Bench scale tests:
for BV, 4:1-4, 8-10
for SVE, 4:1-4, 10, 39-41
examples of, 3:36; 4:39-41

Bernoulli equation, 2:12

Biodegradability, 2:7, 22-24; 9:4

Biodegradation:
aerobic, 3:2-4, 33-35
anaerobic, 8:4
half-life, 2:23
half-saturation constant, 2:22
kinetics, 2:22-24
monitoring, 8:4, 14-15
rates, 2:*22*; 4:10, 44; 8:14

Biofiltration, 5:72-73

Biomass, 5:73

Biopiles (*see Above-ground soil piles*)

Bioslurping:
description, 3:6, *7*
well installation, 5:24, 35-40

Bioventing (BV):
background, 1:4-5; 3:2-3
column tests, 4:1-4, 8-9
combining with SVE, 3:4; 5:1-6, 12
combining with groundwater treatment and/or
NAPL recovery, 3:4-6; 5:24
definition, 3:2
feasibility, 3:30, 36-38; 4:9
field test, 4:9, 43-46; 8:14
in situ respirometry tests (*see In situ respirometry*)

Blower:
curve, 5:24-26, *28*, 30, 33-34
design, 5:51-56
regenerative, 5:*52*, 53
rotary lobe, 5:*52*, 53
liquid ring (vacuum pump), 5:*52*, 53
selection/sizing, 5:6, 51, 54; 8:12
silencers, 5:51

Boiling point:
definition, 2:6
of various compounds, B:3-5

Boring logs, 3:18, 31-32; 5:39, 41, 44

Boussinesq equation, 2:19

Bulk density, 2:7

Bulletin Board Systems, 1:7-8

Cap (*see surface covers*)

Capillary:
forces, 2:8-10; 3:4
fringe, 2:*3*; 3:8, 14; 4:25; 9:4
pressure (head), 2:8-10; 3:33; D:4-6
pressure-saturation
curve, 2:*9*-10; 3:19
definition, 2:9
uses of, 2:9; 3:31, 33, 36, 37; C:6; D:2, 4-5

Carbon adsorption:
operation, 8:3-4, 11-13, 18-19
selection, 5:67-68

Carbon dioxide, 3:19, 30, 33-34; 4:9, 44; 5:58-59; 7:2; 8:14

Catalytic oxidation:
operation, 5:69-70; 8:2
selection, 5:69, 86

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 1:5; 3:2, 37; 11:1

Chemical properties, B:3-25

Cleanup standards, 3:35; 9:2; 11:1

Closure, 9:9

Column test (*see Bench scale tests*)

Commissioning checklist (*see Pre-commissioning checklist*)

Compounds considered amenable to SVE, 3:19-21, 30

Compressible flow, 2:13, 18; D:5

Condensate:
control, 5:48-50; 8:12
treatment and disposal, 5:74-75

Conservation of Mass, 2:13

Constant rate test:
method, 4:26-35
strategy, 4:19

Contaminant:
concentration, 2:5, 6, 22-23; 3:1, 23; 4:1-4, 6-8; 5:1-7, 23, 54, 73, 83; 7:17; 8:3, 5; 9:1, 4; C:1, 4
extent, 3:19, 23
removal, 2:1, 3; 4:4, 6; 7:21-22; 8:5
retardation, 5:6

Contracting, 7:10; 11:4

Controls, *(see Process Controls)*

Cost:
capital, 5:57; 8:16; 10:1-4
documenting, 8:17
estimating, 3:10, 36; 10:1-6
operating, 5:10, 72-73; 8:16; 10:1-6

Covers (*see Surface covers*)

Data:
acquisition, 5:56-57; 7:2, 16, 18
analysis, 3:23-24, 29; 4:13, 15-16
management, 3:23-24; 4: 15; 8:17
quality objectives, 3:23-24, 29; 7:18; 9:1-11
validation, 3:23-24, 29; 9:1-11

Darcy (unit), 2:10

Darcy's Law, 2:11-13; C:2

Databases, 1:7-8

Density:
bulk, 2:7
dry, 2:7
fluid, 2:11
liquid, D:1
particle, 2:7
vapor, 2:5, 13

Desiccation, 3:10, 32; 5:38, 50

Design:
elements, 5:3, 56, 76
documents, 6:1-7

Desorption, 1:4; 2:1, 6; 3:9, 10, 32-33; 5:4; 9:5; C:5

Diffusion:
coefficient, 2:11
diffusion-limited mass transfer, 2:6, 11; 3:15; 4:1-2, 7, 8, 5:4-7, 9, 74; 8:2; 9:4-7, 9; C:5
kinetics, 4:1
oxygen, 2:23

Dissolution, 2:5-6
Dual Phase Recovery, 3:5-*6*; 5:40, 44; 11:3, (*see also Bioslurping*)

Electrical systems:
area classifications, 5:59-66
example design, 5:86-87

Electron acceptors, 3:14, 33

Equipotential, 4:34

Explosion hazard, 3:14; 5:59-64; 7:11; 8:16-17; 11:4

Explosimeter, 5:59; 7:4

Filters:
bio (*see Biofiltration*)
carbon (*see Carbon adsorption*)
particulate, 4:17-18; 5:51

Fire protection, 5:65-66

Fracturing:
hydraulic, 3:15-16
pneumatic, 3:15-16

Friction loss:

calculation, 5:25
chart, 5:*27*

Gas:
constant, 2:5
injection, 3:14-15
molar-masses, B:3-7, 13-18, 22-25
tracer, 3:14-15; D:10

Gradient:
concentration, 2:3
pressure, 2:13, 18; 3:1, 6, 13; 4:27, 34-35; 5:8,10

Granular activated carbon (*see Carbon adsorption*)

Groundwater:
contamination, 1:4; 3:13; 5:11; 9:4
control, 5:24, 40
fluctuation, 3:18, 33; 5:41; 9:4
infiltration, 5:75
level, 7:16; 8:12
measurement, 4:25; 7:16

Half-life (*see Biodegradation*)

Hazard (HAZOP) review *(see Process safety review)*

Head:
conversions, 2:9
loss, 5:25-34
relationship to pressure, 2:12

Health and safety, 4:15, 24; 5:51, 78, 88; 11:4

Heating (in situ), 3:9-11; 5:23-24; 8:2
Patents, 11:3

Heat tracing, 5:40, 45

Henry's Law:
definition, 2:6
constants for various compounds, B:4-5, 11-21

Heterogeneity, 2:11, 14; 3:15, 29, 31; 4:26; 5:6-7, 9, 23, 77; 7:10; 9:4, 6

Humidity (*see Relative humidity*)

Hydraulic conductivity:
definition, 2:10
relationship to permeability, 2:10

Ideal gas law, 2:5

Incompressible flow assumption, 2:18-21; 4:35; 5:15, 17-18, 19, 22; D:8-9

Injection:
- air, 3:*3*, 13-15; 4:9, 43; 5:10-12, 17-23
- heat, 3:9
- gas, 3:14-15; D:10
- nutrient, 3:14
- steam, 3:9, 36; 5:12; 11:3

In situ respirometry:
- method, 4:9, 43, 46
- respiration, 2:23; 3:33-36
- use in monitoring, 8:13, 14-15; 9:7-8

Instrumentation, 3:30; 4:17-18; 5:56-59; 8:8

Kinetics (*see Biodegradation; Diffusion*)

Klinkenberg effect, 2:13; D:5

Leachate:
- collection, 3:11; 5:76

Liners, 3:11; 5:76

Liquid ring pump (*see Blower*)

Manifold, 5:45-48

Manometer, 4:39; 7:17; 8:6

Mass removal rates,
- bioventing testing, 4:8-10
- calculating, 7:23
- column testing for SVE, 4:2-4
- during startup, 7:20-23, *7:21-22*
- evaluating through rebound testing, 9:10-13; Appendix F
- impact of gaseous oxygen on bioventing, 2:22-23
- influence on design strategy, 5:6-7
- monitoring, 8:13
- optimizing, 8:18-19
- pilot testing for SVE, 4:6-8
- *see diffusion-limited mass transfer*
- theoretical ideal, 2:3

Microcosm (*see Column test*)

Microorganisms:
enumeration, 3:33-34; 8:14-15
heterotrophic bacteria, 3:33-34; 8:14-15
respiration, 3:19-20, 33-36; 8:5, 14-15

Modeling:
air permeability, 4:5, 41-42; D:1-12
analytical, 2:10, 14, 24; 4:20-35; 5:24-35, 16-22; C:1; D:1-12
contaminant transport, C:1-2, 5-6
fundamentals, 2:11-22
numerical, 2:24; 5:11, 34; C:1-6
pressure distribution/airflow, 2:10, 13-22; 4:20-35; 5:16-22; D:8-9
scenarios, 2:25-27
summary of available software, C:3-4
use in design, 1:6-8; 2:25-27

Modifications, 8:18

Moisture content (*see Saturation, water*)

Mole fraction:
of gasoline components, B:22-25

Monitoring, 4:8, 9, 12, 22, 25, 27, 47; 7:16-20; 8:4-15; 9:3

Monitoring points, 4:9, 18, 26, *32*; 5:23, *37*, 40-41; D:4-6

Non-aqueous phase liquids (NAPL):
distribution, 2:1, *2*, 3, *4*, 8, 24; 3:1, 23; 5:6; C:6
dense non-aqueous phase liquids (DNAPL), 2:3; 3:23, 36
light non-aqueous phase liquids (LNAPL), 2:3; 3:5-8, 23; 5:24
recovery, 3:5-8; 5:24
saturation (*see Saturation, NAPL*)

Nitrogen, 3:14, 20, 33-34

Nutrients, 3:2, 6, 9, 11, 14, 33-34

Octanol-water partitioning coefficient (*see Partitioning*)

Off-gas treatment:
implications for subsurface design, 5:6-7, 11, 73-74
monitoring, 8:4-15, 16, 20
selection, 5:66-73

Operating curve, 5:54

Operation and maintenance:
monitoring, 8:4-15
optimization, 8:18-19
protocol, 8:20-22
strategy, 8:1-4
troubleshooting, 8:19-20

Optimization, 2:25-27; 8:1-2, 18-19
of pore gas velocity, 5:10
via vertical profiling *(see Pneulog testing)* 4:35-36, *36*
see Rebound

Organic vapor analyzers, 5:58

Oxygen:
uptake rate, 4:10, 43-44

Particulate filters (*see Filters*)

Partitioning:
air-NAPL, 2:3-6
air-water, 2:3-6; 3:32
coefficients, 2:25
consideration of in:
subsurface design, 5:6
technology screening, 3: 16, *17*, 32
octanol-water
of various compounds, 2:6; B:4-7, 13-18
soil-NAPL, 2:3-6
soil-water, 2:3-6

Passive venting, 3:3-4, 33; 5:10-12

Patents, 11:1-3

Peclet number, 2:11

Peripherals design, 5:51, 75-76

Permeability:
air (*see Air permeability*)
intrinsic, 2:10-13; D:1
relative, 2:10, D:1
relationship to hydraulic conductivity, 2:10; D:1
testing (see Air permeability testing)

Permitting (see Regulatory compliance)

pH, 3:20, 34

Piezometer (*see Monitoring points*)

Piezometric surface, 4:25

Piles (*see Above-ground soil piles*)

Pilot tests (*see also Stepped-rate test and Constant-rate test*):
design, 2:25; 4:20-25
equipment, 4:17-18
evaluation, 4:26-35, 42-43, 47-49
extrapolation of data, 2:26
method, 4:19-35
preparation, 4:11-19
strategy, 4:6-8, 10, 18-19

Piping, 5:45, (*see also Pneumatic analysis*)

Pitot tube (*see Airflow measurement*)

Plate count (*see Microorganisms, enumeration*)

Pneulog® testing, 4:8, 35-36, *36*; 9:11-12, *12*

Pneumatic analysis, 5:24-35

Pore gas velocity 4:26, 34; 5:4, *8*-10

Pore volume:
exchange rate, 4:21; 5:4, 12-23
definition, 4:21, 35
selection, 3:1, 3; 4:1; 5:4, 7-11

Pore water, 2:3, 5, 7; 3:1

Porosity:
air-filled, 2:7, 10, 13; 3:33; 4:4, 17, 21, 44, 46; 5:15; C:1; D:3-4, 7
typical, 3:32

Potential:
inertial, 2:12
gravitational, 2:12
pressure, 2:12
total fluid, 2:12

Pre-commissioning checklist, 7:3, 5-9

Preferential flow, 3:14, 15, 18, 37; 4:35, 47; 5:77; 7:17; 8:3, 15; D:4, (*see also Short-circuiting*)

Pressure:
absolute, 2:8, 9, 12, 15; 4:20, 32-33
barometric (*see Barometric pressure*)
capillary (*see Capillary pressure (head)*)
conversions, 2:8, 9
distribution, 2:15, 17, *22*, 26; 4:*34*-38; D:*6*
gauge, 2:9
gradient, 2:13; 4:27, 35
head, 2:8-10, 19
normal, 2:12
standard, 7:23
units of, 2:8, 9
vapor (*see Vapor pressure*)

Pressure-saturation (*see Capillary pressure-saturation*)

Presumptive remedies, 1:5

Process controls, 5:56-59, 82-83, 86; 7:4, 14

Process safety review, 5:78-82

Project team, 2:1; 5:1

Pulsed venting, 8:2-4; 9:1

Pump curve (*see Blower*)

Quality assurance requirements (*see Data*)

Radius of influence:
radius of pressure influence, 2:15-16, 26; 4:21, 33, 34; 5:7, 11, 83; 7:7; 8:2
zone of effective air exchange, 4:21, 34, 47; 5:2, 6, 16-19, *19*, *21*

Raoult's Law, 2:5; 5:6

Resource Conservation and Recovery Act (RCRA), 3:35; 11:1

Rebound, 2:27; 9:7-8; Appendix F

Recordkeeping, 4:14-15; 7:2; 8:17; 9:3, 9, 10

References, 1:1-3, A:1-38

Regenerative blower (*see Blower*)

Regulatory compliance, 3:35-36; 5:73; 11:1

Relative humidity, 2:11; 3:33; 5:48, 67; 8:5, 11-12

Remedy selection, 1:4-6; 2:2, 24-25; 3:1-15, *17*, 36-38; 4:2, 10, 47-48, *49*; 5:3, 5

Reports:
bench and pilot-scale, test, 4:15, 36-46
closure, 9:9
design, 6:1-6
operation and maintenance, 8:17, 20-22
start-up, 7:20-22

Residual saturation:
water, 2:8; D:2, 4-5
NAPL, 2:8; 3:23

Respirometry (*see In situ respirometry*)

Rotary lobe pump (*see Blower*)

Safety (see Health and safety)

Sampling, 3:19, 23-24, 28-31, 34-35; 4:2-4, 8, 10, 14; 5:39, 41, 44; 7:18; 8:12, 15, 18; 9:2-3, 6-7; D:1-4

Sampling/Analysis Plan (SAP):
format requirements, 3:23-27; 7:2; 9:3, 9-10

Saturated zone, 2:*4*; 3:5, *6*, 13, 23; 4:7, 20

Saturation:
air, 2:8; 4:*4*
NAPL, 2:8; 3:23
water, 2:8-9, *9*; 3:19, 31-33; 4:4-5, 45;
5:16; 8:3, 5, 17; D:2, 4-5

Semi-volatile organic compounds (SVOC):
properties of, B:9, 11-13, 16-17

Separators:
air/water, 3:*2*, *7*, *14*; 4:*3*, 7, 8; 5:48-50; 7:6, 19; 8:12
NAPL/water, 3:5-6; 4:18

Short-circuiting, 3:32, 4:8, 44, 47, 48; 5:39, 41, 44, 75-77; 7:17; 8:3, 15; 9:6, (*see also Preferential flow*)

Shutdown:
checklist, 9:8-9
criteria, 9:1-6
post-shutdown monitoring, 9:9-13
strategy, 9:1-2

Silencers, 5:51, (*see also Blowers*)

Site characterization, 3:16-35; 5:1, 23; 7:4

Slip flow (*see Klinkenberg effect*)

Soil:
adsorption coefficient, 2:6
cores, 3:19-20, 38; 4:3, 9
description, 2:7; 3:16, 19-20; 5:39, 41, 44
fraction of organic carbon in, 3:32
moisture (*see Saturation, water*)
porosity (*see Porosity*)
probes (*see Monitoring points*)
properties, 2:7-11; 3:16-20, 32
sampling, 3:16-17, 19-20, 29-30, 34; 4:3-4, 8, 9; 5:39, 41, 44; 8:15; 9:1-6; D:1-4
texture, 2:7; 3:16, 19-20, 37

Soil gas survey, 3:30

Soil vapor extraction (SVE):
background, 1:4; 2:1; 3:1
combining with BV, 3:4
combining with groundwater treatment/NAPL recovery, 3:4-7; 5:24, 40

Solid matrix properties, 3:32, (*see also Soil properties*)

Solubility:
definition, 2:5
of various compounds, B:4-7, 13-18, 21

Solvents, 1:4; 3:2, 10, 19, 36; 5:46, 67; 9:1

Start-up:
checklists, 7:5-9, 12-15
equipment, 7:3-10
monitoring, 7:16-20
report, 7:20-24

Step test (*see Stepped-rate test*)

Stepped-rate test:
example, 4:*20*, *24*, 42
method, 4:19-25
strategy, 4:10, 18-19

Stratigraphy, 3:13, 19; 4:48; 5:39, 41, 44

Stream function, 2:14

Streamlines, 2:17; 4:34-35; 5:9, 16, 83

Stream tube, 5:9, 12, 16-23, *21, 22*

Structural considerations, 5:55

Substrate, 2:22; 3:2, 14; 8:4

Suction, 2:8-10, (*see also Air-entry suction*)

Surface cover, 2:20; 3:*2*, 18, 31; 4:5, 8, 41; 5:12, 15-22, 75, 78; 7:17

Superfund (*see CERCLA*)

Superposition, principle of, 2:16

Supervisory control and data acquisition (SCADA), 5-58

SVOC, *see Semi-volatile organic compounds*

System curve, 4:15, 19, *24*; 5:25, 26, *28*-30, 34

Tanks, 5:55

Technical impracticability, 3:23

Technology screening, 2:1, *2*, 24; 3:1-38; 5:4

Temperature, 2:5-7, 10, 12, 26; 3:9-10, 32; 4:2, 6-8; 5:23, 45, 48, 57-58, 63-65, 67, 70, 86; 7:11, 19; 8:11

Tensiometer, 3:19, 4:4

Tension, 2:8

Texture (*see Soil, texture*)

Thermal enhancement *(see Heating, in situ)*

Thermal oxidation:
operation, 8:2, 16
selection, 5:46, 67-68, 70-71

Toxic Characteristic Leaching Procedure-(TCLP), 4:2

Tracer gas (*see Gas*)

Treatment Standards, 9:2

Trenches, 5:42-44

Troubleshooting, 8:3, 19

Unsaturated zone, 1:4-5; 2:1-4, 8; 3:1, 3, 6, 9, 31, 33; 4:10, 45; 5:1, 4, 39; D:4

Upwelling:
concept, 3:5; 4:20, 25, *26*; 5:10-12, 40, 44; 8:12, 19
measurement of, 4:25-*26*; 7:16

Vacuum, 2:6, 8, 9, 26; 3:1, 5, 7; 4:4-6, 9, 23, *24*-28, 31-32, 34, 42, 47; 5:2, 7, 8, 10, 40, 51-55, 80; 7:11, 16-18; 8:6; 9:7, 9; 11:1, 3; D:8-9, (*see also Pressure*)

Vacuum pump (*see Blower*)

Vadose zone (*see Unsaturated zone*)

Valves:
ball, 5:*47*
butterfly, 5:*47*
diaphragm, 5:*47*
globe, 5:*47*
needle, 5:*47*

Vapor collection system (*see off-gas treatment*)

Vapor concentration:
measurement, 3:30; 4:4, 8, 13, 24; 5:58-59; 7:17-18; 8:13; 9:1-2
trends, 4:39-40; 5:1, 4, 6, 67; 7:20-22; 9:3-5

Vapor flow:
steady-state, 2:11-22
transient, 2:18-21

Vapor pressure:
definition, 2:5
of various compounds, B:3-8, 13-18, 21

Variable speed motor drive, 4:18, 22-23; 5:6, 53, 54

Vent efficiency, 4:19, 31-33

Viscosity, 2:10, 13

Volatile organic compound (VOC):
gaseous phase, 2:5
liquid phase, 2:5
properties of, B:1-25
residual phase, 2:5

Volatilization, 2:5-6

Water saturation (*see Saturation, water*)

Water table (*see Groundwater level*)

Wells (horizontal and vertical):
construction, 5:35-44, *37, 42*
efficiency (*see Vent efficiency*)
extraction, 5:11-12
injection, 5:12
layout, 5:7-24
maintenance, 8:15
screen placement, 5:11-12, 39, 44
spacing, 5:7-24; 7:17; 8:18

Wetting phase, 2:8

Work Plan, 4:11-15; 6:2; 8:20-23